Interstellar dust models consistent with extinction, emission, and abundance constraints

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Objective

To present new interstellar dust models derived for the first time *by simultaneously fitting* the far ultraviolet to near infrared extinction, the diffuse infrared emission and, unlike previous models, the elemental abundances constraints on the dust for three different sets of interstellar medium abundances corresponding to the Sun, F and G stars, and B stars.

Method

The fitting problem reduces to a Fredholm integral equation of first kind, and thus we deal with a typical *ill-posed* inversion problem, in which the grain size distribution is the unknown, which we solve by using *the method of regularization* (e.g. Zubko 1997), which is similar to a constrained χ^2 fit.

Results

We tested 5 classes of interstellar dust models and found them acceptable:

1. **BARE-GR** models consist of PAHs (polycyclic aromatic hydrocarbons) + graphite grains + silicate grains and are identical in composition to the Li & Draine (2001) model, but with different size distributions that are optimized to comply with the above constraints;
2. **COMP-GR** models consist of PAHs + graphite grains + silicate grains + composite particles (different mixtures of silicate, amorphous carbon, organic refractory material, water ice, and voids);
3. **BARE-AC** models consist of PAHs + hydrogenated amorphous carbon (ACH2) grains + silicate grains;
4. **COMP-AC** models consist of PAHs + hydrogenated amorphous carbon (ACH2) grains + silicate grains + composite particles;
5. **COMP-NC** models contain PAHs + silicate grains + composite particles; these models contain neither bare carbon particles.

Five models, one from each class, are shown on the work flow chart to the right. The discrepancies of all 15 resulting models are presented on the chart below.

We estimated the uncertainties in the resulting grain-size distributions by Monte Carlo simulations in conjunction with the regularization method.

Conclusions

1. There exist several distinct interstellar dust models that simultaneously fit the observed extinction, infrared emission, and abundances constraints.
2. We believe that adding more constraints, such as e.g. interstellar polarization or X-ray scattering halos, could narrow a set of our resulting dust models.
3. From the three abundance sets that we fit, it is harder to fit the B star abundances, thus hinting that solar and the F and G stars interstellar abundances look more preferable.

Literature cited

Arendt, R.G., et al. 1998, ApJ, 508, 74
Bohlin, F.C., et al. 1978, ApJ, 224,132
Cardelli, J.A., et al. 1989, ApJ, 345, 245
Dwek, E., et al. 1997, ApJ, 475, 565
Fitzpatrick, E.L. 1999, PASP, 111, 63
Holweger, H. 2001, in Joint SOHO/ACE workshop "Solar and Galactic Composition", ed. by R.F. Wimmer-Schweingruber, American Institute of Physics Conference proceedings, vol. 598, p.23
Li, A., & Draine, B.T. 2001, ApJ, 554, 778
Meyer, D.M., et al. 1997, ApJ, 490, L103
Meyer, D.M., et al. 1998, ApJ, 493, 222
Sasseen, T.P., et al. 2002, ApJ, 566, 267
Sofia, U.J., & Meyer, D.M. 2001, ApJ, 554, L221
Zubko, V. 1997, MNRAS, 289, 305

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For further information

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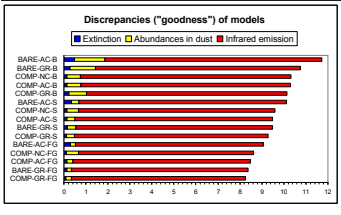

Work flow chart